Space Weather Technical Forecast

Issued on Saturday 15 February 2025 at 01:17 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1. Likely R1/R2. Chance becoming Likely Active 24-hour electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate solar activity was observed in the last 24 hours, with three M-class flares occurring: these mostly from AR3990 in the southeast, with peak flare an M1.8 observed at 14/2057UTC. There are currently twelve sunspot regions on the visible disc, of which eight are numbered. There are five notable regions at present, the first of which is the aforementioned AR3990 in the southeast nearing centre disk. This spot has a large central asymmetric spot surrounded by peripheral spots, most of which are small, though one of opposite polarity has now developed rudimentary penumbra. AR3992 in the southwest, saw a continued spreading tendency and a trend towards a more open character. AR3994 near south centre disk is a small and apparently unremarkable region, yet has been the source of a number of flares and faint CMEs recently. AR3995 unusually remains within the southern coronal hole, bifurcating the coronal hole. Finally, the new region near the southeast limb, has continued to rotate into view, and is rather bright on SDO94 imagery. All other spots are relatively simple with only little changes observed.

Two or three faint CMEs were observed perhaps leaving the region AR3994 during 14 Feb, though confidence is low. These may give glancing impacts days 2-3 (16-17 Feb).

Solar Wind / Geomagnetic Activity: Solar winds as measured at L1 by ACE, showed an ongoing connection to a fast wind, likely that emanating from CH14/-. The solar wind speed was erratic due to the low solar wind density (single figures ppcc), but showed an overall slight rise from 450 +/-50km/s to 550 +/-50km/s by the period's end. The IMF showed a flat trend around moderate (7-8nT), with an overall peak of 9nT. The north-south component varied between +6 and -9nT, with this mainly anti-aligned with Earth's field to accentuate geomagnetic activity. The net result of the above solar wind measures was Unsettled to Active geomagnetic activity, with a peak of G1/Minor storm (Kp 5) in the UTC early hours of 14 February.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 persisted at Background levels.

High energy electron flux (greater than 2MeV) at GOES16 was periodically at High levels in a trace interrupted by geomagnetic activity, with a peak of 6600pfu at 14/1600UTC. The associated 24-

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hour fluence was on a rising trend, becoming briefly above Active for a single interval at 14/2100UTC. The 14/0001UTC observation was 9.68e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Isolated M-class flares are Likely, with a level trend now expected (barring development) in the absence of any significant departures or arrivals.

Solar Wind / Geomagnetic Activity: Two or three faint CMEs give a chance of glancing impacts days 2-3 (16-17 Feb). Coronal hole fast winds from CH14/- continue, with a gradual rise and then fall over a roughly three-day span (easing by 18 Feb) is most likely, with speeds peaking around 550-600km/s.

Predominantly Unsettled to Active geomagnetic conditions are expected throughout, with a Chance of G1/Minor geomagnetic storms (Kp 5) on days 1-3 (15-17 Feb), initially due to coronal hole high speed stream influences but perhaps later due to possible glancing CMEs. By day 4 (18 Feb) solar wind speeds and and current CME risks are expected to have eased with geomagnetic activity falling back to Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: High energy proton flux is forecast to persist at Background levels, with a marginally increasing Slight Chance of a S1 event given the westward progression of current active regions.

The high energy electron flux is generally expected to become diurnally high each day, with an increasing Likelihood of reaching Active fluence, though confidence is low, and the forecast may prove volatile until CH14 and CH15 rotate closer to the western limb.

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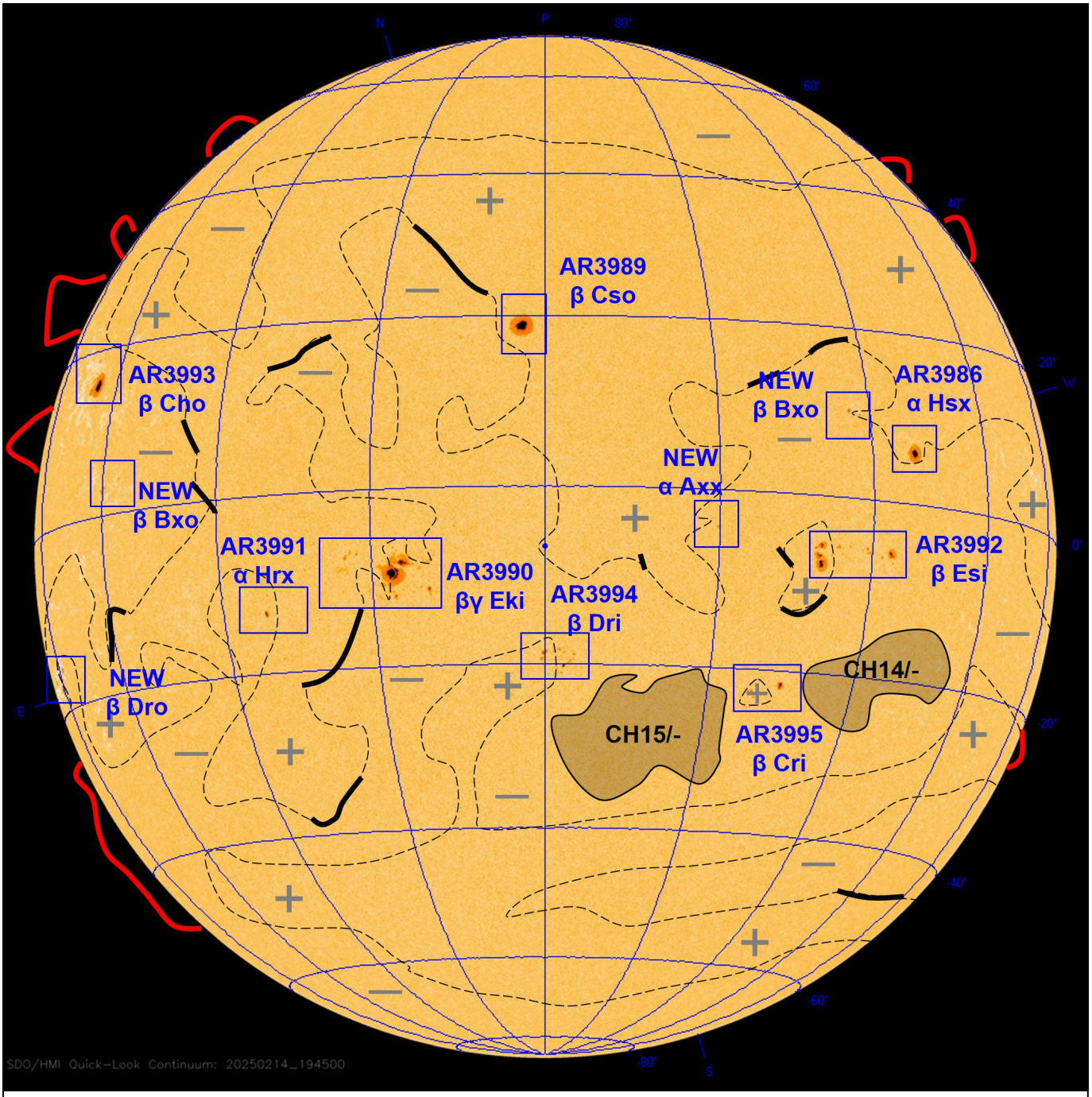
Figure 1: Solar synoptic map valid 14/1945 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Two or three faint CMEs were observed perhaps leaving the region AR3994 during 14 Feb, though confidence is low due to the lack of clear dimming in imagery and the interaction of the nearby coronal hole fast winds. The analysis of imagery is also complicated further by suspected far sided events. There is therefore a chance of glancing impacts days 2-3 (16-17 Feb).

Coronal hole fast winds from CH14/- continue, though the unusual development of AR3995, within the boundaries of CH14/-, splitting the rear portion into CH15/-, has perhaps occurred too late to have any impact on the continuity of its fast wind at Earth, and the previous thoughts of a sustained period of restive geomagnetic active are maintained, with a seamless transition from CH14/- into CH15/-. The latest MOSWOC Enlil run persists in its thoughts of the fast wind lasting until around 20 Feb, with only minor deviation due to the aforementioned glancing CMEs. This is deemed unphysical given the stature of the causative coronal hole. Instead, a gradual rise and then fall over a roughly three-day span (easing by 18 Feb) is perhaps preferred, with speeds peaking around 550-600km/s, i.e. a slight increase may yet occur.

Predominantly Unsettled to Active geomagnetic conditions are Expected throughout, with a Chance of G1/Minor geomagnetic storm (Kp 5) on days 1-3 (15-17 Feb), initially due to coronal hole high speed stream influences but perhaps later due to possible glancing CMEs. By day 4 (18 Feb) solar wind speeds and and current CME risks are expected to have eased with geomagnetic activity falling back to Quiet to Unsettled (Kp 0-3). The main forecast uncertainty is perhaps the duration of the enhancement, although the peak magnitude is not likely to depart from G1.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	40	30	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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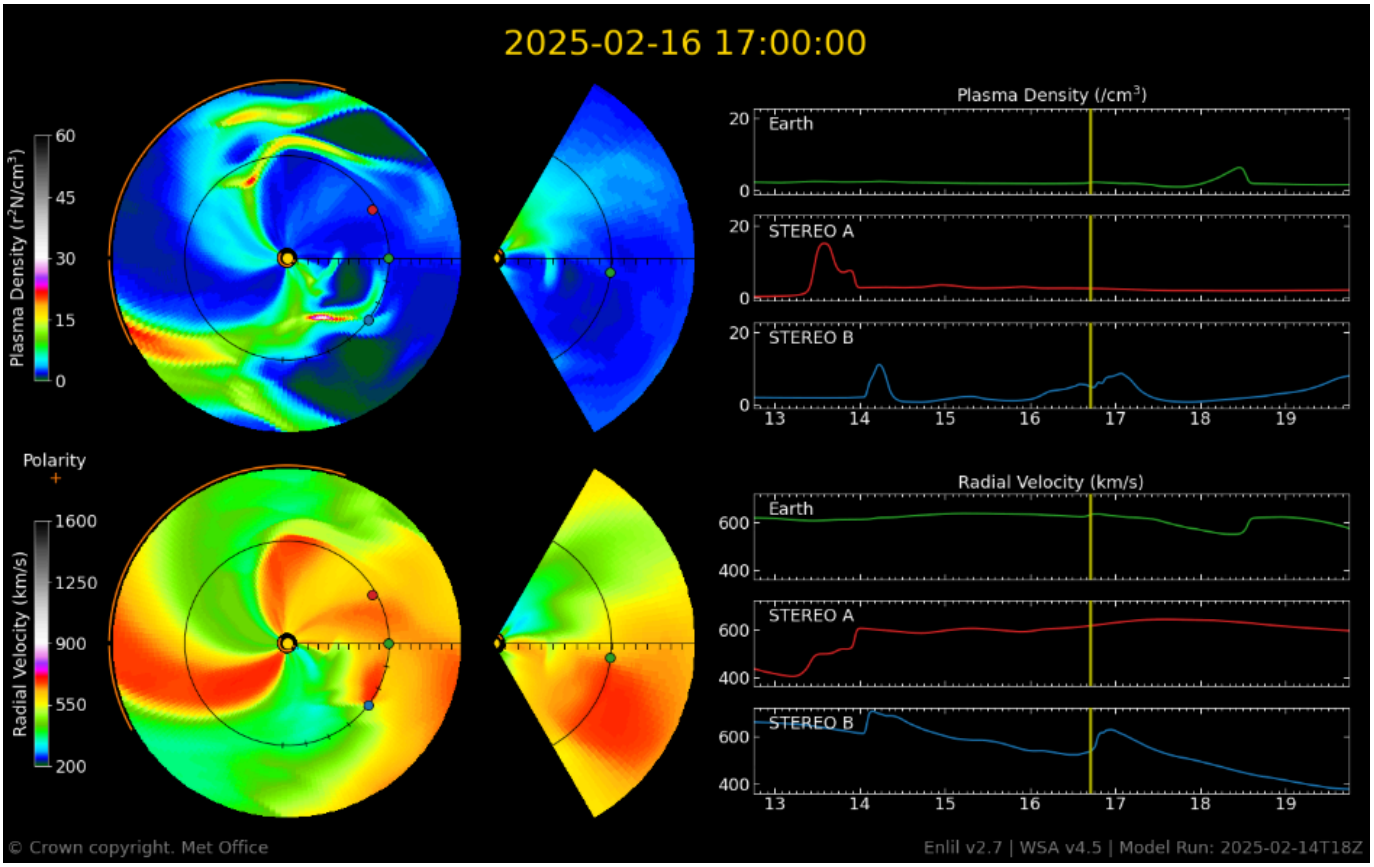
Figure 2: MOSWOC ENLIL, timestamp showing the possible glancing arrival of CME/s as they arrive at 1AU.



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Radio Blackouts - X-Ray Flares

Moderate solar activity was observed in the last 24 hours, with three M-class flares occurring: these mostly from AR3990 in the southeast, with peak flare an M1.8 observed at 14/2057UTC.

There are currently twelve sunspot regions on the visible disc, of which eight are numbered. There are five notable regions at present, the first of which is AR3990 in the southeast nearing centre disk. This spot has a large central asymmetric spot surrounded by peripheral spots, most of which are small, though one of opposite polarity has now developed rudimentary penumbra leading to it's more complex classification. This spot has shown an overall growing trend in recent hours. AR3992 in the southwest, saw a continued spreading tendency and a trend towards a more open character. AR3994 near south centre disk is a small and apparently unremarkable region, yet has been the source of a number of flares and faint CMEs recently. AR3995 unusually remains within CH14, bifurcating the coronal hole. Finally, the new region near the southeast limb, has continued to rotate into view, and is rather bright on SDO94 imagery. All other spots are relatively simple with only little changes observed.

Further isolated M-class flares are considered Likely, probably from AR3990, AR3992, or from the region on the southeast limb.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	60	60	60	60
Very Active	R3-R5 (X Class)	No	10	10	10	10

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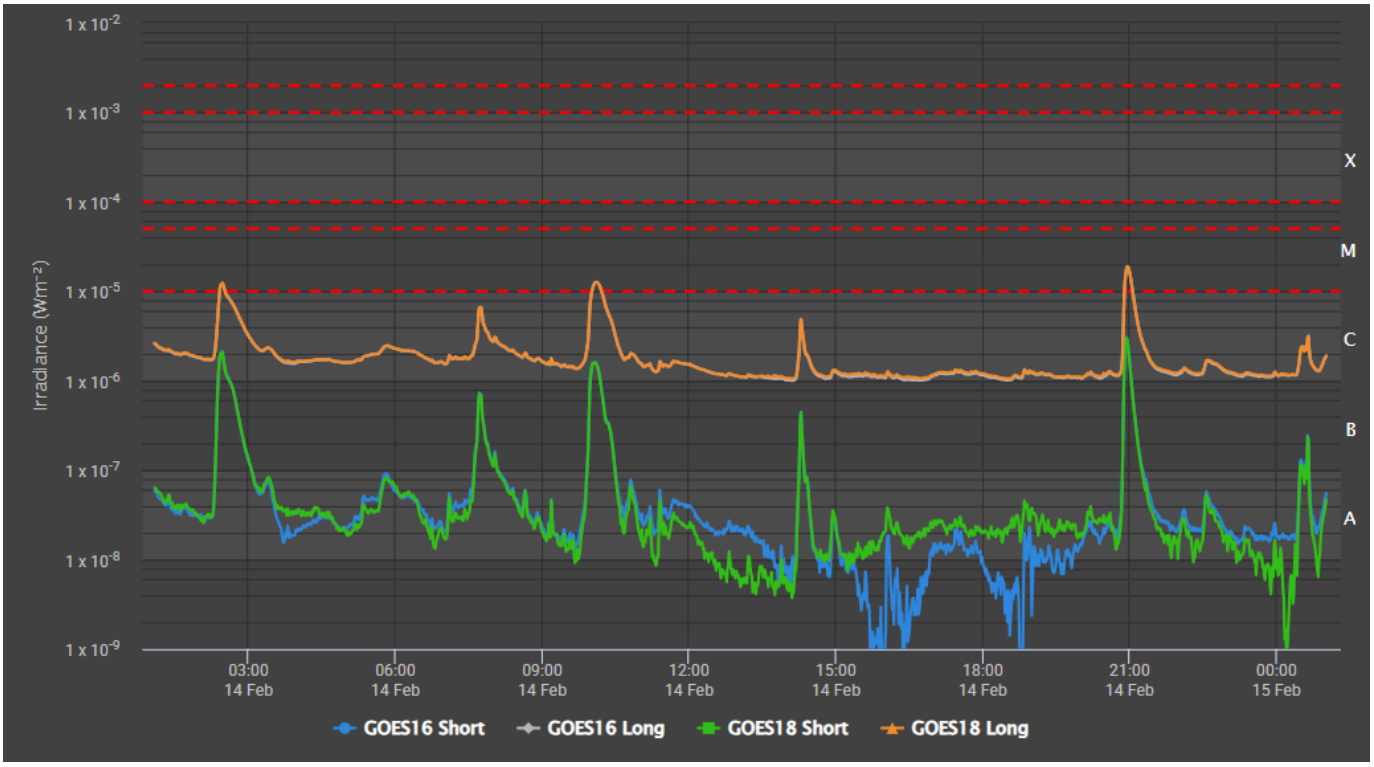
Figure 3: 24 hour X-ray trace



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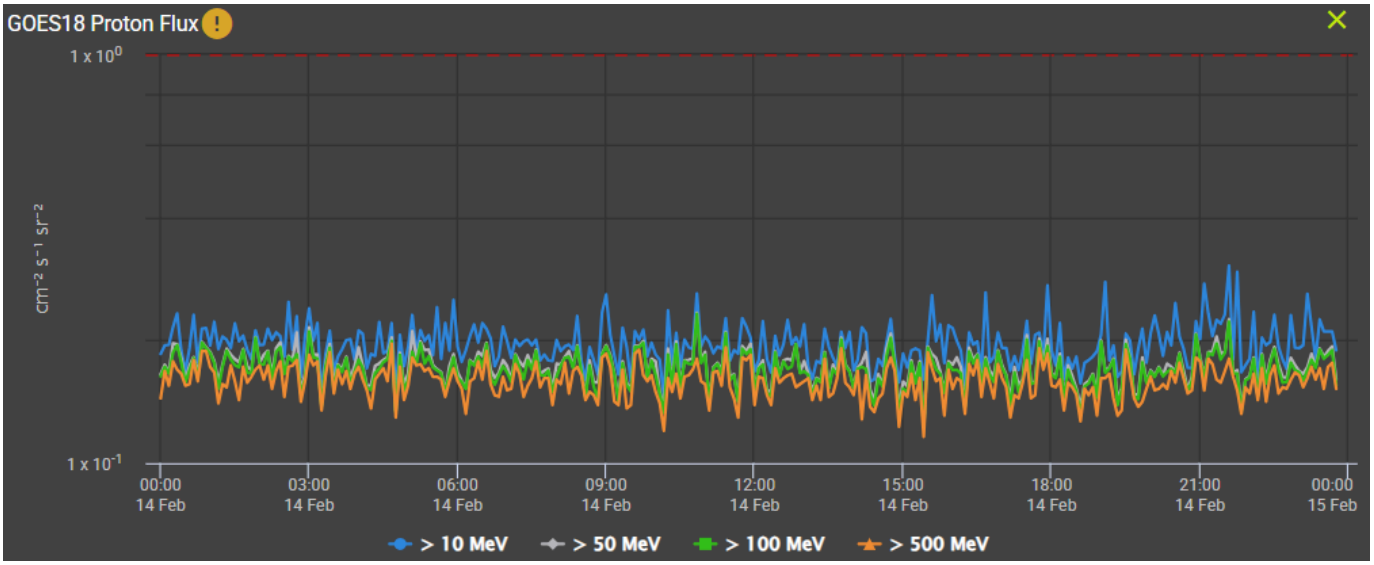
Solar Radiation Storms (High Energy Protons)

GOES18 proton flux is most likely to persist at Background levels, but with a slowly increasing daily Slight Chance of enhancement from any notable flares from AR3992 in the western hemisphere or AR3990 as it rotates into a more favourable position into the western hemisphere.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: 24 hour Proton trace.



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High Energy Electrons (≥ 2MeV)

Confidence in the high energy electron forecast remains low. There are competing factors affecting flux levels, the sustained solar winds and geomagnetic activity from CH13/- and CH14/- have been sufficient to charge but not significantly compress the Van Allen belt and its High electron populations at GEO. This has led to diurnal peaks at high electron flux levels. Occasional drop-outs to Normal Background flux are still probable. In time as the coronal hole high speed stream eases, flux levels may become more persistently high. On the other hand possible glancing CMEs may also act to clear a portion of electrons from GEO.

An associated slight increasing trend is expected for electron fluence levels, with an increasing Likelihood of rising above Active by days 3 and 4 (17/18 Feb). MOSWOC REFM is proving quite reactive to current counts at GEO and shows a relatively flat trend close to Active.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	50	50	60	60
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 5: MOSWOC REFM integrated flux/fluence observations/recurrence/forecast.

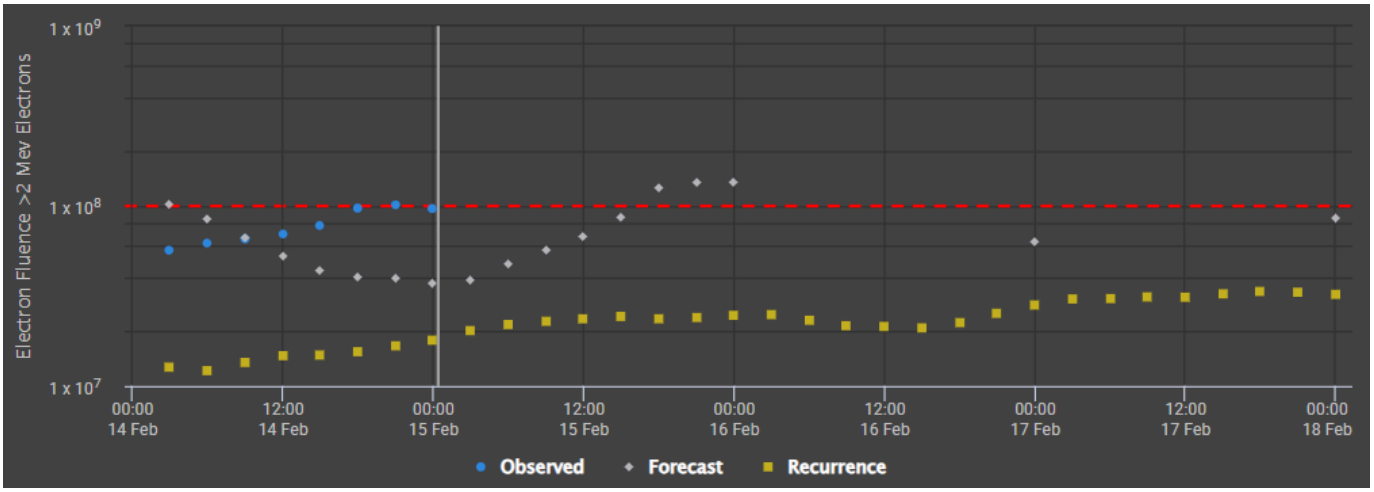

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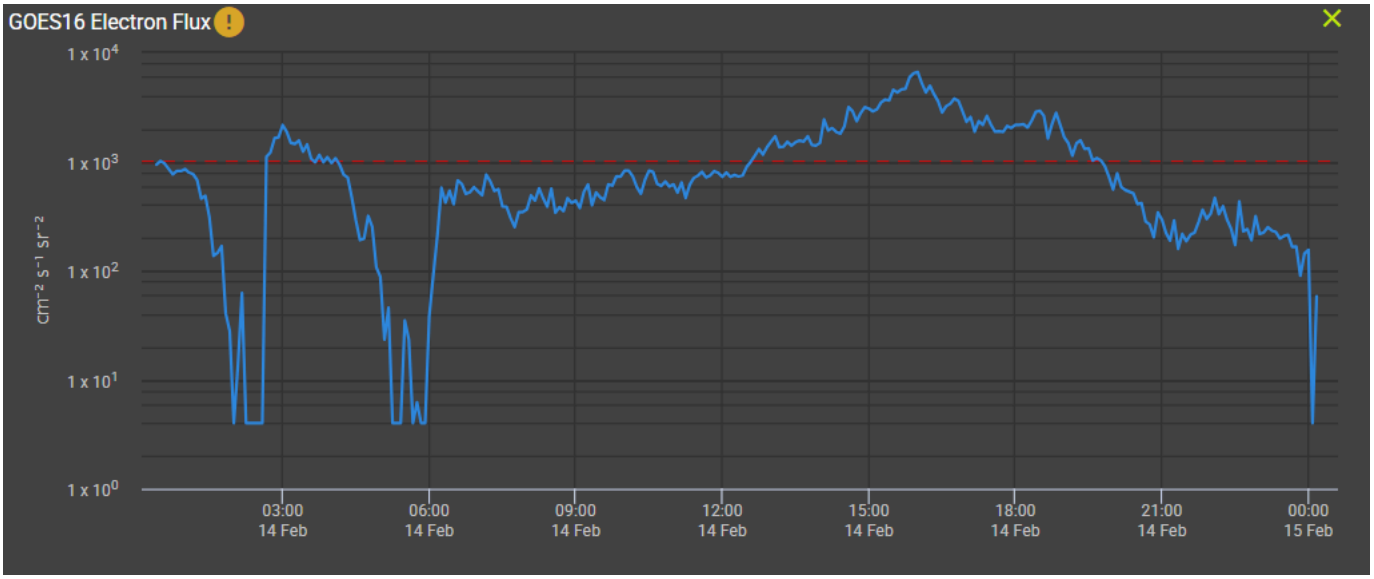
Figure 6: 24 hour electron flux trace.



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